

What is claimed is:

[Claim 1] A pump for dry particulate material, comprising:

a pump chamber defined in part by a gas permeable member;

a first pinch valve and a second pinch valve wherein each said pinch valve comprises a member that defines part of a flow path for material through the pump, and wherein said pinch valve members open and close in response to pneumatic pressure applied thereto;

wherein during pump operation material flows into said chamber under negative pressure and material flows out of said chamber under positive pressure;

said first and second pneumatic pinch valves being operable to control flow of material into and out of said chamber.

[Claim 2] The pump of claim 1 wherein each said pinch valve comprises a flexible member that has a material passage therethrough and said passage is closed by gas pressure applied to an outer surface of said flexible member.

[Claim 3] The pump of claim 2 wherein each said flexible member is disposed in a pressure chamber that is connectable to a source of positive air pressure.

[Claim 4] The pump of claim 1 wherein said first and second pinch valves can be separately actuated.

[Claim 5] The pump of claim 1 wherein material enters and exits said pump chamber through a single opening.

[Claim 6] The pump of claim 1 wherein said pump chamber is separately connectable to a source of purge gas.

[Claim 7] The pump of claim 1 wherein said pump chamber is defined by a cylindrical interior surface of said gas permeable member and is open at opposite ends thereof, wherein material enters and exits said pump chamber through a first opening at one end of said gas permeable member and wherein

a second opening at an opposite end of said gas permeable member is a purge gas inlet.

[Claim 8] The pump of claim 1 comprising a second pump chamber and third and fourth pneumatic pinch valves, wherein material is transferred to a common outlet by alternate flow through said first and second pump chambers.

[Claim 9] The pump of claim 8 wherein said first, second, third and fourth valves can be separately actuated.

[Claim 10] The pump of claim 1 wherein said pinch valves are disposed in a transparent valve body.

[Claim 11] The pump of claim 1 comprising a material inlet for material flow into the pump and a material outlet for material flow out of the pump, said material inlet and material outlet in fluid communication by a flow path that includes said pinch valves and said pump chamber, wherein said flow path further comprises a replaceable wear item disposed in a support block.

[Claim 12] The pump of claim 1 comprising a modular assembly of a manifold body, a valve body and first and second material flow path bodies, said manifold body, valve body and flow path bodies being connected together when the pump is fully assembled.

[Claim 13] The pump of claim 12 wherein said manifold body retains said gas permeable member, said valve body retains said pneumatic pinch valves and said flow path bodies each define one or more flow paths for material through the pump.

[Claim 14] The pump of claim 13 wherein said manifold body comprises a plurality of ports that are connectable to sources of pressurized gas and negative pressure so that all pneumatic energy for operation of the pump enters said manifold body first.

[Claim 15] The pump of claim 14 wherein pneumatic passageways are formed in said manifold body and interconnect with pneumatic passageways in said valve body to operate said valves.

[Claim 16] The pump of claim 15 wherein a plurality of ports that are connectable for pneumatic pressure to operate said valves and said pump chamber are disposed in a common plane and connectable to a pneumatic supply manifold.

[Claim 17] A pump for dry particulate material, comprising:

a pump chamber defined in part by a gas permeable member wherein during pump operation material flows into said pump chamber under negative pressure and material flows out of said pump chamber under positive pressure;

a first pinch valve and a second pinch valve wherein each said pinch valve comprises a member that defines part of a flow path for material through the pump, and wherein said pinch valve members open and close in response to pneumatic pressure applied thereto;

said first and second pneumatic pinch valves being operable to control flow of material into and out of said pump chamber.

[Claim 18] The pump of claim 17 wherein said pinch valves can be independently actuated open and closed with respect to each other.

[Claim 19] The pump of claim 17 wherein said pinch valves can be independently actuated open and closed with respect to application of negative and positive pressure to said pump chamber.

[Claim 20] The pump of claim 19 wherein said pinch valves can be independently actuated open and closed with respect to each other.

[Claim 21] A dense phase pump for dry particulate material, comprising:

a modular unit having a pneumatic manifold body and a pneumatic valve body; said manifold body having a pump chamber defined in part by a gas permeable member wherein during pump operation material flows into said

pump chamber under negative pressure and material flows out of said pump chamber under positive pressure;
said valve body having a first pinch valve and a second pinch valve wherein each said pinch valve comprises a member that defines part of a flow path for material through the pump, and wherein said pinch valve members open and close in response to pneumatic pressure applied thereto, said first and second pneumatic pinch valves being operable to control flow of material into and out of said pump chamber;
said manifold body and said valve body being releasably held together as a unit when the pump is completely assembled.

[Claim 22] The pump of claim 21 comprising at least one material flow path body disposed between said manifold body and said valve body.

[Claim 23] The pump of claim 21 comprising a removable wear part that forms a portion of a material flow path within the pump, said wear part being disposed in a material flow manifold body that is mounted to said valve body.

[Claim 24] The pump of claim 21 wherein pressurized air for operation of said pinch valves first enters said manifold body and flows internally the pump to said valve body.

[Claim 25] A pump for dry particulate material, comprising:

a pump chamber defined in part by a gas permeable member and a pressure chamber in fluid communication with said member, said member having a first end and a second end, powder entering and exiting said member through said first end only;

wherein during pump operation material flows into said chamber under negative pressure and material flows out of said chamber under positive pressure;

said member second end being connectable to a source of purge gas whereby said chamber is purged by flow of purge air straight through said pump chamber.

[Claim 26] A pump for dry particulate material, comprising:

a pump chamber defined in part by a gas permeable member disposed in a pressure chamber;
a first pinch valve and a second pinch valve wherein each said pinch valve comprises a member that defines part of a flow path for material through the pump;
wherein during pump operation material flows into said pump chamber under negative pressure and material flows out of said pump chamber under positive pressure;
said first and second pneumatic pinch valves being operable to control flow of material into and out of said chamber with timing that is independently controlled of timing that positive and negative pressure is applied to said pressure chamber.

[Claim 27] A pump for dry particulate material, comprising:

a pump chamber defined in part by a gas permeable member disposed in a pressure chamber;
a first pinch valve and a second pinch valve wherein each said pinch valve comprises a member that defines part of a flow path for material through the pump;
wherein during pump operation material flows into said chamber under negative pressure and material flows out of said chamber under positive pressure;
wherein flow rate of material from the pump is controlled as a function of duration time of said negative pressure.

[Claim 28] A pump for dry particulate material, comprising:

a pump chamber defined in part by a gas permeable member disposed in a pressure chamber;
wherein during pump operation material flows into said pump chamber under negative pressure and material flows out of said pump chamber under positive pressure during a pump cycle;
wherein flow rate of material from the pump is adjustable independent of the pump cycle duration.

[Claim 29] The pump of claim 28 comprising a suction pinch valve and a delivery pinch valve that control flow of material in and out of the pump chamber respectively, said pinch valves having open/closed times that are separately controllable from the pump cycle time.

[Claim 30] The pump of claim 28 comprising a control circuit that adjusts duration of time that the negative pressure is applied to the pressure chamber to adjust flow rate.

[Claim 31] The pump of claim 30 comprising a suction valve and a delivery valve that control flow of material in and out of the pump chamber respectively, said valves having open/closed times that are separately controllable with respect to the negative pressure duration time.